# SHORED TRENCHES AS VEHICLE BARRIERS

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# Conditions have Changed


The Pentagon Building

- **We are at war with terrorists**
- **We have to change the way we:**
  - **Construct our buildings**
  - **Protect ourselves**

# Protecting Perimeters Is A Element of Installation Security

- Train security personnel to respond effectively
- Use obstacles and barriers to control the movement of vehicles
- Deny intruders any concealment
- Conceal critical assets and deceive the intruders
- Maintain the ability to get emergency personnel and equipment into an area when needed

# Potential Effects from Vehicle Bombs

Crater at Khobar Towers

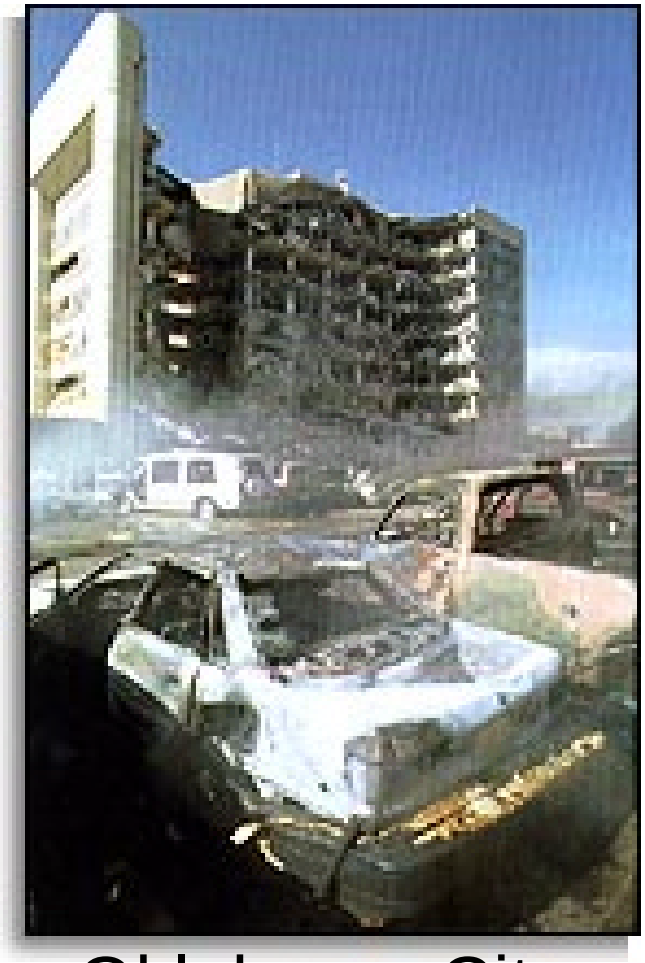
**A 1000-lb car bomb will :**

- **Produce a lethal air blast out to 125 feet**
- **Destroy a reinforced concrete wall at 30 feet**

# Potential Effects from Vehicle Bombs

**A 2000-lb car bomb will:**

- **Produce major structural damage to buildings at 170 feet**
- **Produce lethal flying glass at a distance of over 800 feet**



Oklahoma City

# Reducing Damage

- **Key factor in reducing damage is "Standoff Distance"**
- **"Standoff Distance" is the distance away from buildings required to safely protect against lethal blast and major structural damage**

# Trenches are Excellent Barriers

WWII Tank Trap

**Open trenches have drawbacks:**

- **Can be used for concealment**
- **Can become defensive positions**
- **Complicate area surveillance systems**
- **Are not aesthetically acceptable**

# Engineering a Barrier Trench

**A barrier trench:**

- **Must be deep enough and wide enough to stop any intruding vehicle**
- **Must be collapsible under weight of intruding vehicle**
- **Must be covered**
- **Must be obstructed to prevent movement or concealment of any intruder**
- **Must contain fire-proof shoring**
- **Must be aesthetically pleasing**

# Stopping a Wheeled Vehicle

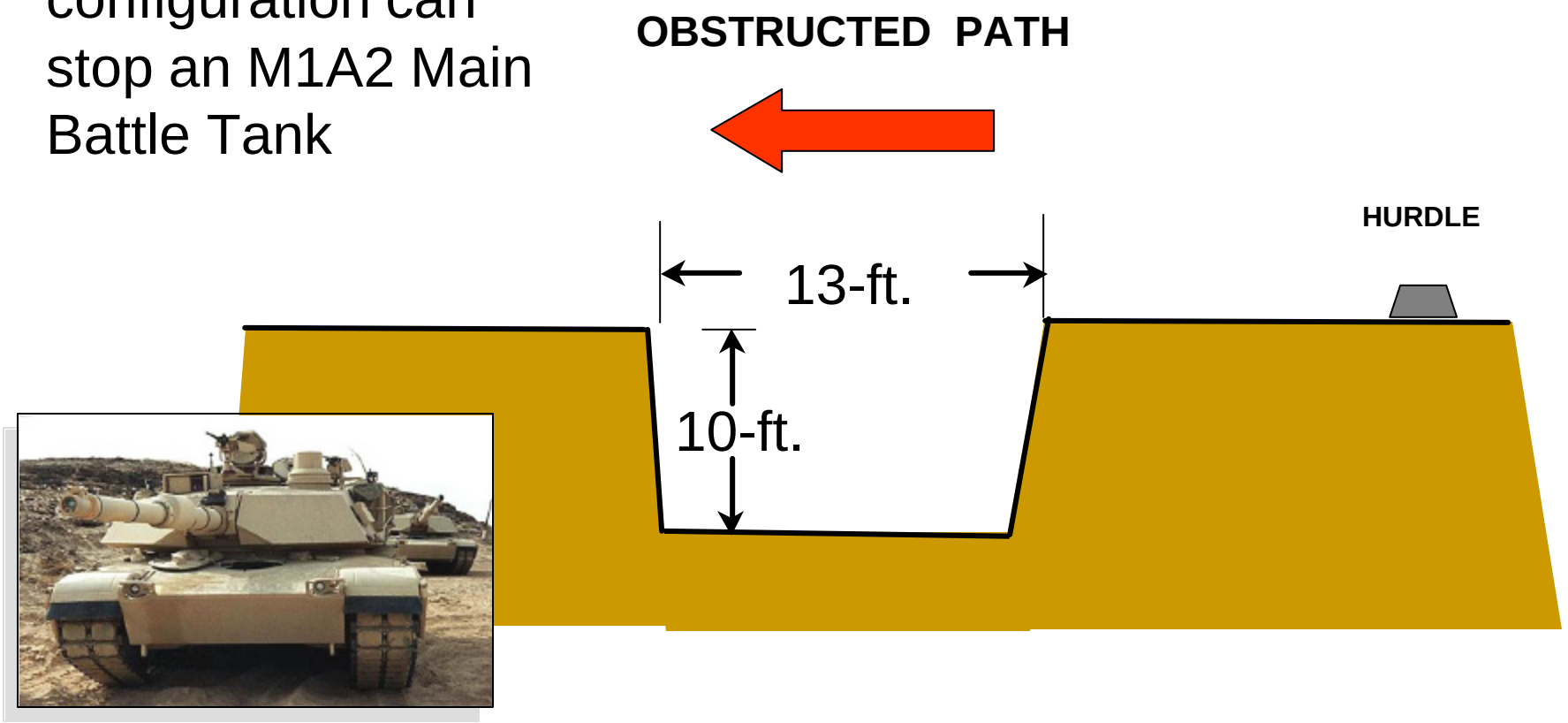
- **Vertical obstacles are more effective than sloping obstacles**
- **Vertical obstacle heights greater than one-half the tire diameter will halt a vehicle**
- **“Self-bridging” does not occur**

# Stopping a Tracked Vehicle

- **Vertical obstacles are more effective than sloping obstacles**
- **Vertical obstacle heights greater than the height of the center of the front idler will halt a vehicle**
- **Limit of “self-bridging” is less than 10 feet**

# Configuration of Standard Trapezoidal Trench

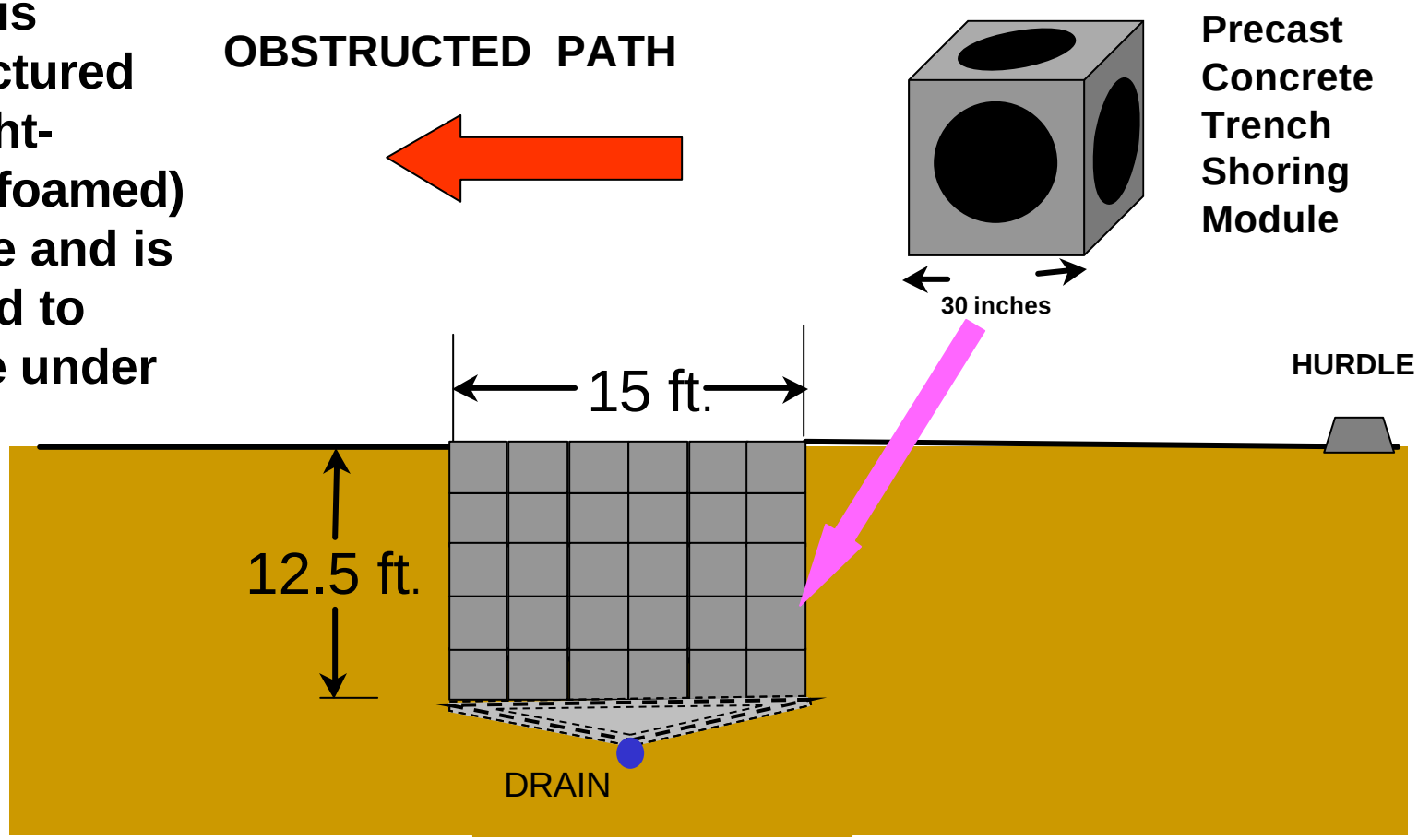
This trench configuration can stop an M1A2 Main Battle Tank




From: FM 5-34

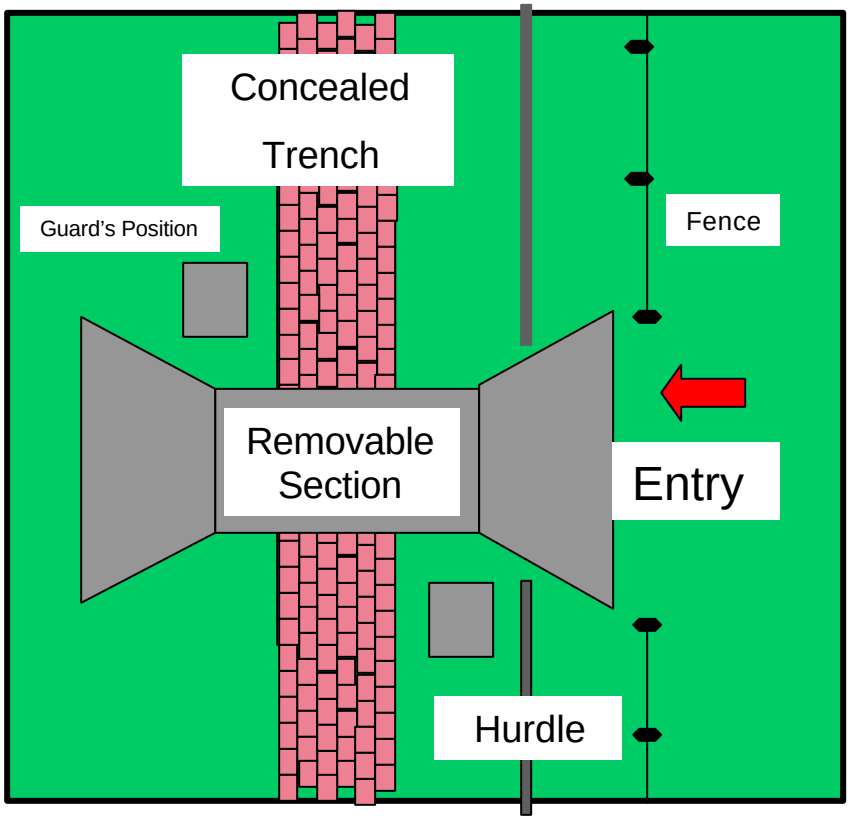
# Trenches Are Shored Using Precast Concrete Modules

**Module is manufactured from light-weight (foamed) concrete and is designed to collapse under load.**




**Anchoring can be achieved using scrap tires embedded in light-weight (foamed) concrete**

# Trenches Shored Using Collapsing Precast Concrete Modules




**Plan view**

**Not to scale**

- **Concealed trench resembles roadway**
- **Does not obstruct observation on site**
- **Cannot be used for concealment or attack**
- **Removing the bridge member closes the entry to all vehicles**

# Trenches Shored Using Collapsing Precast Concrete Modules (2)

- **Can be aesthetically acceptable**
- **Can be scaled in depth and width to defeat any threat**
- **Requires minimal maintenance**
- **Attacker cannot tell if trench is a few inches or several feet deep**

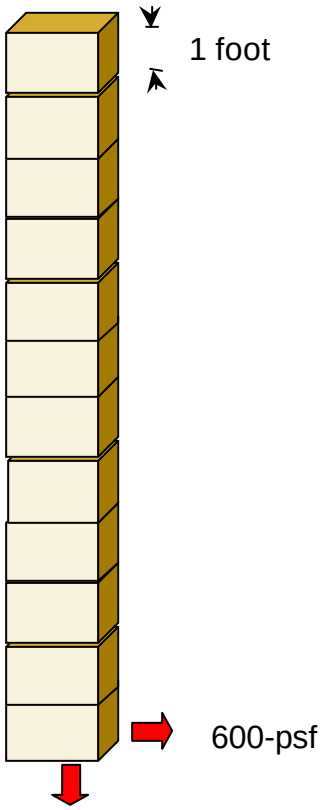
Truck at Khobar Towers

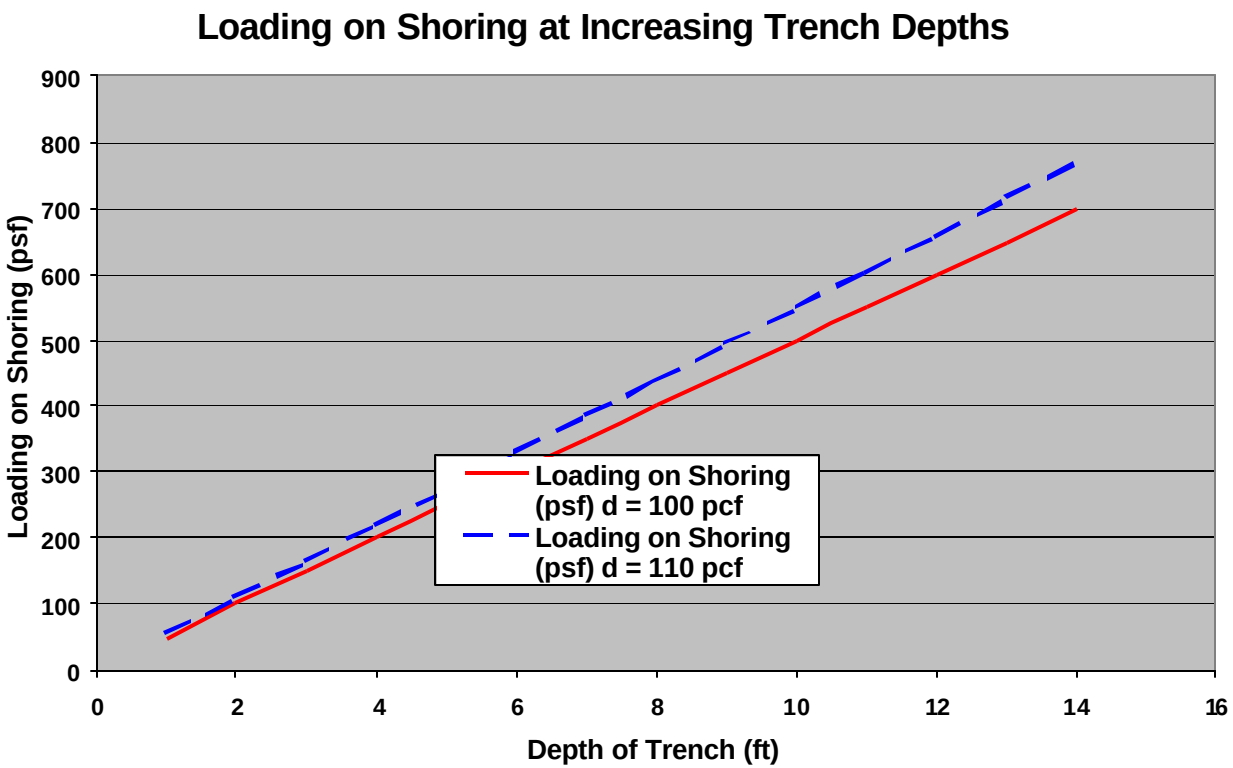
# Precast Concrete Modules Are Manufactured Using Foamed Concrete

- Foamed concrete at 40- to 50- pcf offers best materials for construction
- Strong in compression, but weak in flexure
- Permanent, low maintenance, damp-proof
- Fireproof
- Scrap tires provide reinforcement

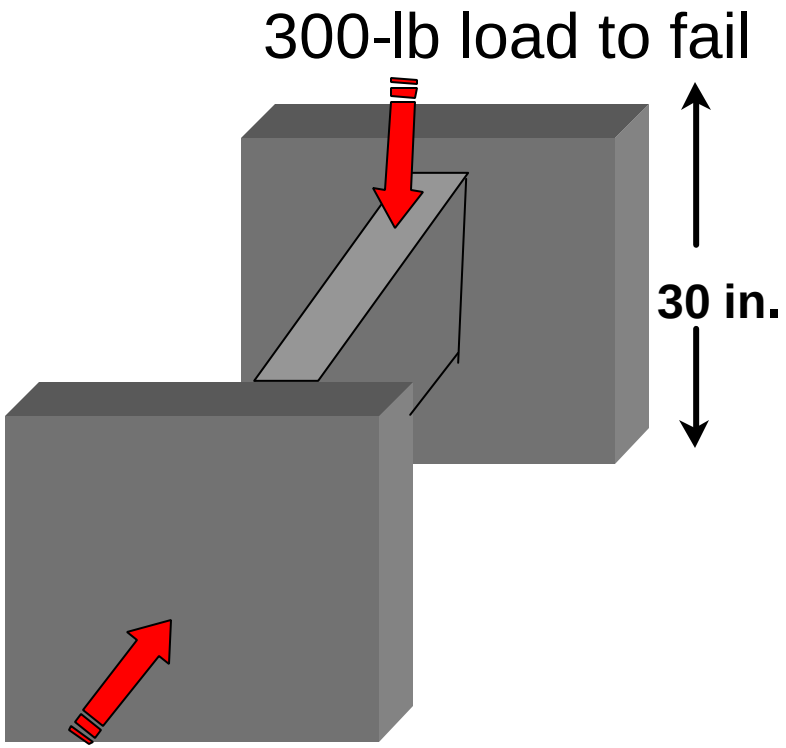
# Loading of Trench Shoring Elements

## Soil Density = 100-pcf



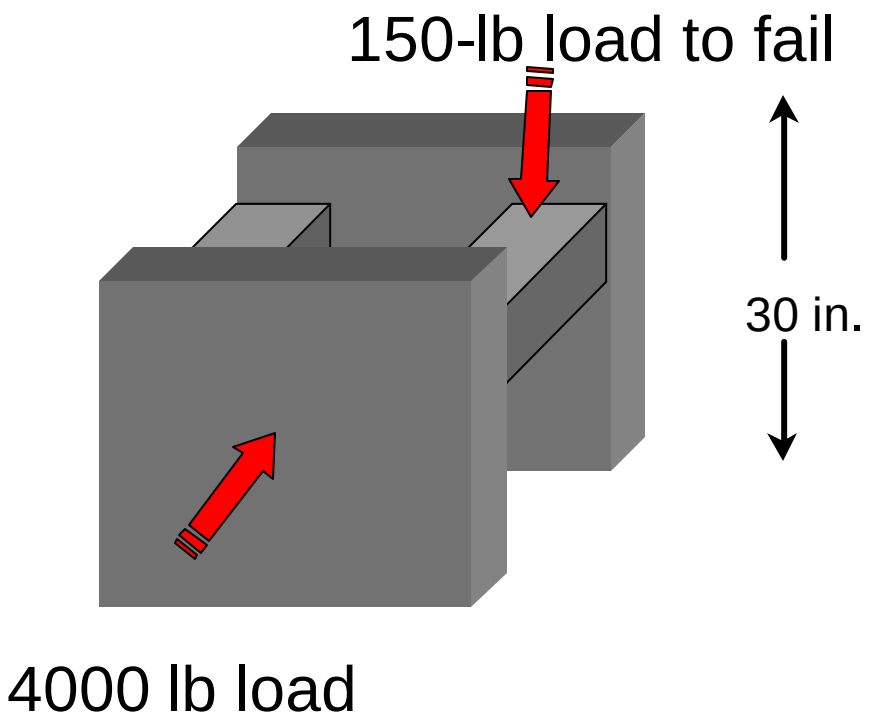
# Simple Panel and Single Strut Shoring Module Design



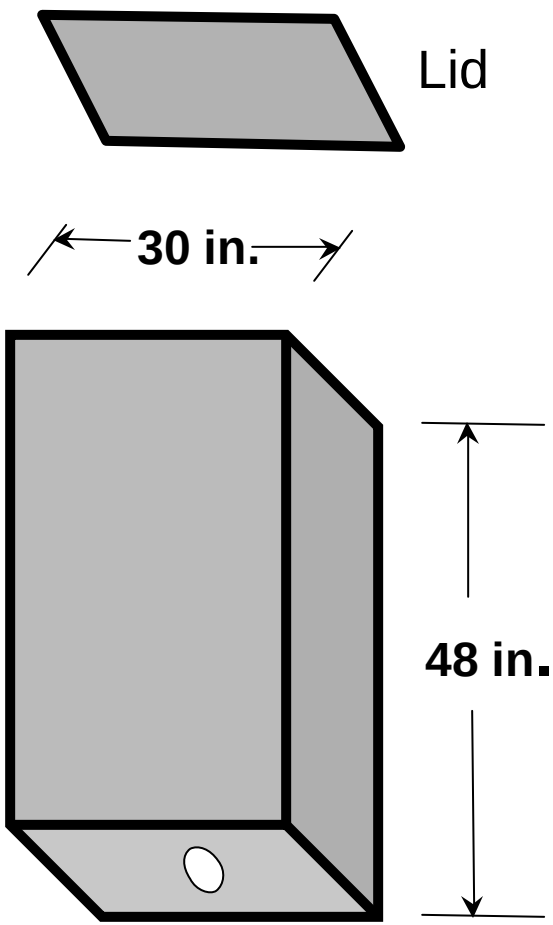

- **Strut in compression can carry 400-psi**
- **Strut in flexure fails at 25- to 40-psi loading**
- **Simple single strut could fail in flexure under a 300-lb load**
- **Falling vehicle should provide a dynamic loading**

# Simple Panel and Multiple Strut Shoring Module Design

- **Struts in compression can carry 400-psi**
- **In flexure struts fail at 25- to 40-psi loading**
- **Each single strut could fail in flexure under only a 150-lb load**



# Hollow Block Module Design




- **Design is based on failing the thin foamed concrete lid first**
- **Dynamic load of falling vehicle collapses the side walls**
- **Unit can accept horizontal loading in trenches over 12 feet deep**
- **Unit is anchored in bottom of trench using an embedded scrap tire**

# Summary

- **Perimeter trenches are effective obstacles that can be easily scaled to deny access to most types of vehicles**
- **Trenches cannot be pushed out the way, dragged out of the way and breached with explosives**
- **Shoring the trenches with foamed concrete modules obstructs the interior of the trench to make it useless for concealment of an intruder**

# Summary (Con't.)

- **Foamed concrete shoring can provide lateral support for the trench walls, but will fail when loaded vertically by an invading vehicle**
- **Foamed concrete panels can cover and conceal the top of the trench**
- **Portable bridging systems allow emergency vehicles access**
- **Trenches can be combined with fences and barriers and made aesthetically acceptable**

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